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PACKAGING PERFORMANCE TESTING
OF A
CORRUGATED FIBERBOARD BOX (16 IN. BY 16 IN. BY 16 IN.), CONTAINING FOUR
1-GALLON RECTANGULAR METAL CANS – PACKING GROUP I,
FOR LIQUIDS

SURFACE TRANSPORTATION MODES ONLY

Date: May 30, 2003

AFPTEF PROJECT NUMBER: 03-P-101
POP TEST ID NUMBER: DODPOPHM/USA/DOD/AF69/DLA-F006

Part 1.

A. Title: PACKAGING PERFORMANCE TESTING OF A CORRUGATED FIBERBOARD BOX (16 IN. BY 16 IN. BY 16 IN.), CONTAINING FOUR 1-GALLON RECTANGULAR METAL CANS – PACKING GROUP I

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B.

TEST REPORT APPLICABILITY STATEMENTS see section 2E.

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Performing Activity: AF Packaging Technology and Engineering Facility
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Specific Authority: Distribution Statement F. Further dissemination only as directed by AFMC LSO/LOP or higher DoD authority.

Requesting Organization: Defense Distribution Center
DDC-J-3/J-4-0
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Requesting Organization's Reference(s):
(1) Letter 23 December 2002

Part 2. Data Sheet**A. Exterior Shipping Container****UN Type:** Fiberboard box**UN Code:** 4G**NSN:** 8115-00-190-5002**Specification Number(s):** ASTM D5118, Style RSC, ASTM D4727, Type CF, Class WR, Var SW, Gr 400, V3c**Container Manufacturer:** Lynchburg Sheltered Industries, Lynchburg, VA 24501**Date of Manufacture:** February 2003 (GSA advice code "2G" – newest stock)**Material:** Corrugated Fiberboard**Container Dimensions:** 16 in. x 16 in. x 16 in. ID**Closure (Type/Method):** ASTM D1974, Sealing Method 2B (7-Strip Method).**Closure Specification Number(s):** A-A-1830 clear tape, 2-inch, NSN 7510-00-266-6715.

Reinforcement (Type/Method): ASTM D1974, Reinforcement Method 2B, using 1-inch wide filament reinforced tape. Exception: 2 horizontal girthwise bands, one placed 4.5 inches from the top and one placed 4.5 inches from the bottom, were used before filling the box; 2 vertical girthwise bands, placed 4.5 inches from parallel box sides and crossing the closure line of the box flaps at right angles, were used after filling the box, and before sealing the box. A 6-inch piece of sealing tape may be applied at a right angle across the seam formed by the inner flaps to permit easier closure of the outer flaps.

Reinforcement Specification Number(s): A-A-1687 Fiber Reinforced Tape, 1-inch; NSN 7510-00-582-4772.

Absorbent Material Description: Vermiculite, Fine Grain, Palmetto Vermiculite Company, Incorporated, Grade C-3; Absorbent GP, Absorption Corporation [Hazmatpac A-900, HAZMATPAC Inc. also used in test.]

Additional Description: N/R**B. Inner Packaging of Combination Packaging****Type:** Oblong metal can.**NSN:** N/A**Manufacturer/Distributor:** Consolidated Plastics Co., Inc.**Date of Manufacture:** N/R**Manufacturer's Number(s):** 41937LG**Capacity:** 1 gallon**Dimensions:** 6 5/8 in. x 4 1/8 in. x 9 1/2 in. (can body); opening 1-inch diameter.**Closure (Method/Type):** Metal screw cap, I.D. 1 3/8 in.

Secondary Closure (Method/Type): One strip of reinforced tape (as above) wrapped a minimum of 1 1/2 times around and overlapping the cap(s) base and the can neck(s).

Additional Description: Inner packaging of tested item (see photos, Figures 1 – 3, and drawing).

1. Apply horizontal girthwise bands of reinforced tape before filling box, to prevent compression of absorbent from deforming box sides.

2. Line the box with a 4-mil gusseted polyethylene bag, size 22 in. x 22 in. x 47 in., minimum dimensions.

3. Place approximately 3.25 inches of absorbent in bottom of box. [If using Absorbent GP, tightly compress the bottom layer and add/compress absorbent tightly to a depth of 3.25 inches.] Place 4 cans on the absorbent layer in a pinwheel pattern (see Figure 1), centered and evenly spaced, adjacent can sides approximately 1.5 inches apart. There should be approximately 2 inches between the box sides and the can sides. Fill all open space with absorbent until can tops are reached (if using Absorbent GP, tightly compress approximately every 2 inches and add material until can top is reached, without denting can sides, and cover with a minimum of 3.25 inches of tightly packed absorbent). Cover with a minimum of 3.25 inches of tightly packed absorbent. **NOTE: The quantity of absorbent used does NOT meet the requirements of AFMAN 24-204(I), Atch 20. This packaging is not intended for transportation by Military Aircraft.**

4. Shake or press down and firmly compress, and add absorbent if necessary to make a tight pack within the outer container.

5. Twist bag and tape closed with fiber reinforced tape.

6. Closure IAW 2A.

C. Actual Product: Not Used**NSN:** NA**Specification:** Unknown**UN/DOT/IMO/IATA Proper Shipping Name:** Unknown**United Nations Code Number:** Unknown**United Nations Packing Group:** I**UN Hazard Class:** Unknown **DOT Hazard Class:** Unknown**IMO Hazard Class:** Unknown **IATA Hazard Class:** Unknown**Physical State:** LIQUID**Items or Amount per outer container:** Four 1-gallon cans [7.2 kg (15.8 lb) each, calculated]**Gross Weight (packaged with vermiculite):** maximum of 39.01 kg (86 lb)**Gross Weight (packaged with Absorbent GP):** maximum of 37.65 kg (83 lb)**Density/Specific Gravity:** 1.8**Drop Height:** 1.8 meters (71 in.)**Stacking Weight/Force Required:** 248.68 kg (548.25 lb) [based on test sample using vermiculite]**Additional Description:** N/A**Vapor Pressure (liquids only) at 50°C:** Unknown**D. Test Product: Used****Name:** Water and sand**Physical State:** LIQUID (with solids)**Items or Amount per outer container:** Four 1-gallon metal cans [7.2 kg (15.8 lb) each]**Gross Weight (packaged with vermiculite):** maximum of 39.01 kg (86 lb)**Gross Weight (packaged with Absorbent GP):** maximum of 37.65 kg (83 lb)

[Gross Weight (packaged with Hazmatpac A900 – information only): maximum of 47.63 kg (105 lb)]

Density/Specific Gravity: 1.8**Drop Height:** 1.8 meters (71 in.)**Stacking Weight/Force Required:** 248.68 kg (548.25 lb) [based on test sample using vermiculite]**Additional Description:** N/A**E. Test Applicability-** See test results in Part 6.

(1) Tests documented herein are design qualification. It is the responsibility of the government shipper/certifier to fully verify design compliance and packaging material quality.

(2) Drop testing performed herein was tested in accordance with DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This joint DoD policy document allows packaging to be drop tested more than once provided the packaging continues to pass the 49CFR 178.603 requirements. Questions about or clarification of this policy can be sought from the respective preparing activities of the regulation.

(3) DoD contractor use of this test report or its resultant certifying mark only with the permission of the testing activity AND as specified in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.

(4) Pass/fail conclusions were based on the particular specimens, both inner and outer containers, and quantities of each submitted for test. Extrapolation to other manufacturers, applications, commodities, inner containers, container sizes, or lesser internal quantities is the responsibility of the packaging design agency or applicable higher headquarters and the limitations documented in 49CFR. Extrapolation of test results based on lesser than minimum UN/DOT required test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

(5) Reference to specification materials has been made based on one of the following methods: supplied by AFPTEF, provided by the requester, markings printed on, attached to or embossed on the packaging.

(6) Testing performed in accordance with 49CFR 170-180, except as documented in this report.

(7) Performance testing was undertaken and completed at the request of an agency responsible for management of the dangerous good(s). The completion of successful UN/DOT testing does not, by itself, authorize the marking and transportation of the

dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

(8) The DOT performance tests are intended to evaluate the performance of the entire packaging configuration's ability to prevent the release of contents during conditions normally incident to transportation. The criteria used to evaluate container system performance is whether the contents of the packaging are retained intact. The successful completion of the recommended tests does not ensure undamaged delivery.

(9) Tests performed and documented, herein, in no way verify Government supplier's operations (included but not limited to: internal procedures, suppliers, or manufacturing processes) comply with the DOT's or international's regulations. The testing facility has no knowledge and assumes no knowledge, that specific material testing requirements (i.e. plastics - only allowed to use regrind from the same operation; specific vendor plastic formulations including quantity of carbon black, ultra-violet inhibitors or pigments, or production run's individual leakproofness tests) are or were performed by the manufacturer(s) listed herein, unless otherwise noted in the report.

Part 3. Introduction.

Brief description of why specific tests were performed and rationale for the test product selected (if applicable).

Packing Group I testing was requested on the above stated configuration. For lesser volumes, variations to testing requirements can be found in 49 CFR, part 178.601(g). The tested configuration is intended for surface transportation modes only.

Since the required drop height for a liquid with a specific gravity of 1.8 could not be obtained using only water as the test substance, sand was added to the bottles filled with liquid to ensure a test weight equal to a liquid with a specific gravity of 1.8.

Each packaging was subjected to appropriate drop and vibration testing as prescribed by ASTM D4919. These tests are designed to simulate the shock and vibration a package configuration may encounter during conditions normally incident to transportation. The order of testing was drop test followed by the vibration test; the stacking test was performed on an empty outer container. The Cobb test was performed on samples taken from boxes not otherwise used in testing.

Although this configuration was tested using vermiculite, Absorbent GP and Hazmatpac A900, only the configurations with vermiculite and Absorbent GP passed all tests, and therefore only vermiculite or Absorbent GP may be used as the absorbent in this configuration used.

The use of one sample packaging configuration for multiple tests and drops is DoD policy as stated in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This option was exercised in this test as noted in Part 6.

Part 4. Tests Required/Performed (as applicable).

NOTE: Packagings fabricated from fiberboard, paperboard, or paper, including composite containers with outer fiberboard containers, should be conditioned for a minimum 24 hours prior to any testing. Standard conditions $23 \pm 3^{\circ}\text{C}$ ($73 \pm 4^{\circ}\text{F}$) and $50 \pm 2\%$ relative humidity apply.

A. Leakproofness test. 3 outer containers each individually tested for 5 minutes (30 minutes for plastic containers). **Not applicable.**

B. Hydrostatic Pressure Test. 3 outer containers each individually tested for 5 minutes at 15 psig. **Not applicable.**

C. Stacking Test. One test per outer container, 3 containers required. Compression by a top load is calculated to simulate a stack height of 3 meters, maintained for 24 hours. **NOTE:** If only one configuration sample is tested, test duration shall be 72 hours.

Static weight. Apply the calculated weights using a constant load evenly over the entire container.

$$M = \frac{m(3000-h)}{h}$$

where: m = container's gross mass (as shipped) in kilograms = **39.01 kg**

h = container's height in millimeters = **406.4 mm** (effective height for container in stack)

M = constant minimum load mass in kilograms = **248.68 kg**

or:
$$W = \frac{w(118-h)}{h}$$

where: w = container's gross weight (as shipped) in pounds = **86 lb** (highest sample weight)

h = container's height in inches = **16 in.** (effective height for container in stack)

W = constant minimum load weight in pounds = **548.25 lb**

NOTE: Where the contents of the test sample are non-dangerous liquids with relative density different from that of the liquid to be transported, the force shall be calculated in relation to the latter.

Information - This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

D. Drop Test. 5 drops in order: flat on the top, bottom, long side, short side and top corner. The drop height shall be appropriate for the packaging group of the commodity. The container shall strike a target which shall be a rigid, non-resilient, flat, and horizontal surface. For other than flat drops, the center of gravity shall be vertically over the point of impact. **NOTE:** All drops may be made on one sample. If the sample fails after drops 2 through 5, it may be replaced by another sample identically loaded. This option was used as noted in Part 3.

For solids and liquids, if the test is performed with the actual contents to be transported or with a non-hazardous material having essentially the same characteristics; or for liquids, if the test is performed with water and the intended contents has density less than 1.2 g/cm³ (specific gravity less than 1.2) the drop height shall be:

<u>Packing Group</u>	<u>Drop Height</u>
I	1.8m (70.9 in.)
II	1.2m (47.2 in.)
III	0.8m (31.5 in.)

Round the drop height up to the first decimal.

E. Vibration Test (domestic requirement). One test per container, total of three test specimens.

The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately **0.2 cm** (1/16 in.) thickness can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-peak) displacement of **2.54 cm** (1 in.). Perform tests in accordance to 49CFR 173 Subpart B, Appendix C and 49 CFR 178. **NOTE:** If only one configuration sample is tested, test duration shall be 3 hours.

F. Fiberboard Water Resistance (Cobb) Test. One test per fiberboard specimen, total of six.

Strong, solid or double faced corrugated fiberboard (single or multi-walled) must be used, appropriate for the capacity and the intended use of the box. The water resistant outer surface must not increase in mass greater than **155 grams per meter² (0.0316 pounds per foot²)** after 30 minutes in accordance with International Standards Organization (ISO) 535 or Technical Association of the Pulp and Paper Industry (TAPPI) T441 or ASTM D 3285. Three individual fiberboard specimens shall be exposed on the wire side and another three on the felt side.

Part 5. Criteria for Passing Tests.

A. Leakproofness Test. There must be no leakage of air from the packaging. **Not applicable.**

B. Hydrostatic Pressure Test. Any leakage is cause for rejection. **Not applicable.**

C. Stacking Test.

No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show deterioration which adversely affects transportation safety or show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety.

D. Drop Test.

Each packaging containing liquids shall be leakproof when internal and external pressures are equalized. Composite and combination containers shall not exhibit damage to the outer packaging likely to adversely affect transportation. In addition, the inner packaging shall not leak into the filling substance or lading.

E. Vibration Test.

No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

F. Fiberboard Water Resistance Test.

The calculated water absorption of all samples shall be less than **155 g/m²**.

Part 6. Discussion and Test results.

Narrative description of test results, including any rationale for variations. For each packaging to pass, all applicable tests must be performed and pass criteria listed herein.

A. Leakproofness Test. Not applicable.

B. Hydrostatic Pressure Test. Not applicable.

C. Drop Test. Pass with vermiculite and Absorbent GP absorbents/cushionings only.

Tested at standard conditions: 23°C, 50% RH. Each packaging was dropped 1.8 meters onto the required four flat sides and a bottom corner (equivalent to a top corner).

Packaging with vermiculite: The cans cushioned by vermiculite were mildly damaged and there was no leakage from the cans. One can was flattened on a short vertical side, and there was some handle deformation on two of the cans. There was also “pinching” of seams and corners on two of the cans, and slight outward bowing of can tops. The can nearest the impact corner, and the can opposite that corner, sustained the worst damage. All cans were still able to stand upright. There was no damage after any one drop to the outer packaging that would be likely to cause leakage from, or weakening of, the package during transportation.

Packaging with Absorbent GP: The cans displayed moderate damage and there was no leakage from any of the cans. The tops and bottoms had a more pronounced outward bowing, sides were more flattened, and there was slightly more pinching of seams and corners; handles were mildly deformed. All cans were still able to stand upright. There was no damage after any one drop to the outer packaging that would be likely to cause leakage from, or weakening of, the package during transportation.

Packaging with Hazmatpac A900: Although no cans leaked, they displayed moderate to severe damage. Three of the four cans had severely pinched seams and corners, sides were flattened and dented, tops and bottoms bowed outward, and the handle on one can was broken at an attachment point. These cans could not stand upright. The extent of the damage could easily result in leakage during transportation. The outer container was not significantly damaged, however, one strip of vertical girthwise tape, and the top strip of sealing tape, did break across the top box flaps and one flap came unsealed along the edge closest to the broken tape. See Figures 5, 8 - 11.

D. Stacking Test. Pass

Duration: 72 hours at standard conditions: 23°C, 50% RH. One empty closed outer container was stacked with 650 lb (exceeding requirements) for 72 hours. There was no damage to the box which could result in damage to the inner item, no crushing, nor stack instability. No other adverse results were noted. See Figure 4.

E. Vibration Test. Pass

Duration: 3 hours at ambient. The same packagings used in the drop tests were also used for the vibration test. Each packaging was tested on an electro-hydraulic vibration table which was set at 1-inch vertical double amplitude (peak-to-peak) displacement, at a frequency such that the packaging was raised from the platform. The distance was measured using a 1/16-inch feeler gage. At approximately 4.05 Hz the feeler gage could be passed between the bottom of the package and the table surface. There was no additional damage to the outer container caused by the vibration and no leakage from the inner containers. The vermiculite had settled in the package approximately 1 to 1.5 inches, especially in the box center where it was unsupported by the cans; this was probably due more to the vibration test than to the drop test.

The test duration of 3 hours with one container exceeds the 49 CFR requirements. See Figure 6.

F. Water Resistance (Cobb) Test. Pass

Test at standard conditions: 20°C, 50% RH.

As required by 49 CFR part 178.516, ASTM D 3285 Water Absorptiveness of Nonbibulous Paper and Paperboard (Cobb Test) was performed on specimens cut from the lot of boxes used in the drop stack and vibration tests. The test period (exposure of the samples to water) was 30 minutes.

3 Specimens were tested on the exterior side. Average **116.71 g/m²**.

Values : 123.11 g/m², 117.18 g/m², 113.93 g/m², 114.56 g/m², 114.77 g/m²

3 Specimens were tested on the interior side. Average **126.24 g/m²**.

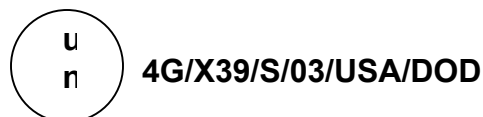
Values : 118.74 g/m², 131.77 g/m², 126.31 g/m², 125.66 g/m², 128.74 g/m²

0 Specimens exceeded the 155 grams per square meter maximum limit.

Part 7. Performance Marking on Container:

The container specified herein passes the DoT and international regulatory requirements to the extent tested.

Equivalent DoD built or grandfathered containers MAY also qualify for the following marking as directed by DoD policy documents.

**Part 8. References**

A. 49 CFR 170-180

B. DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55A/MCO 4030.40A - Packaging of Hazardous Materials

C. ISO 535/TAPPI T 441/ASTM 3285 - Determination of Water Absorption of Paper and Board (Cobb Method)

D. ISO 3574 - Cold-reduced carbon steel sheet of commercial and drawing quantities.

E. ASTM D999 - Methods for Vibration Testing of Shipping Containers.

Part 9. Distribution List

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